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OBSERVATIONAL CONSTRAINTS ON INTERSTELLAR DUST MODELS

J. H. HECHT, J. A. HACKWELL, and R. W. RUSSELL
Space Sciences Laboratory, The Aerospace Corporation, Los Angeles, California 90009 USA

No single model has been able to account for all of the observed spectroscopic properties of interstellar or circumstellar dust. The reason for this is that, despite the agreement that the grains are composed of silicaceous/metal oxide and carbonaceous material, there is strong disagreement as to their exact structure and composition. This led Draine and Lee (1984) to use interstellar extinction data to define an interstellar graphitic material; new observational findings have made even that identification uncertain. But the great advantage of their approach is that they used observations at *all* of the wavelengths available to define the material. In this poster we attempt a variation of that approach. We examine recent UV and IR data and attempt to put constraints on the possible types of interstellar grain composition, and to connect these constraints with grain models. What follows is a summary of some of the important constraints imposed by the observations.

IR OBSERVATIONS

a) The astronomical "20 μm" feature, which actually occurs between 18 and 19 μm, is usually attributed to SiO bending. However, most absorptions from bulk silicates, meteoritic or interplanetary material, or laboratory cosmic dust analogues show a band longward of 20 μm. Only a few substances, such as amorphous olivine, have been shown to have an 18-19 μm feature as well as having a 9.7 μm silicate bump (see Hecht et al.,1986). In addition, the feature near 18 μm, which could also be caused by isolated MgO particles (Huffman, 1977), is apparently never found without corresponding evidence for one at 9.7 μm. This appears to rule out an independent origin for the two features.

b) The 3.1, 6.0, 6.8, and 6-7 μm absorptions seen around protostellar sources or in very dense cloud regions have been attributed to the presence on or in the silicate grains of organic ices, water ice, carbonates, or water of hydration (e. g. Hecht et al. 1986). Their absence in interstellar extinction implies that at least those silicates are free from such contamination and contradicts the recent model which attributes the 2175 Å bump in the interstellar extinction curve to hydrated silicate grains (Jones et al. 1987).

c) The UIR (or OIR) bands are almost certainly due to the presence of hydrocarbon material. They were first identified (Leger and Puget, 1984; Allamandola et al., 1985) as PAH molecules but the lack of corresponding absorption features in the UV somewhat contradicts that proposal. Other possible identifications arising from the PAH model are the presence of small amorphous CH grains also referred to as QCC or HAC (Hecht, 1986; Sakata et al. 1984; Goebel; 1986) . A very recent suggestion which follows from an earlier proposal by Goebel(1986) is that the bands are actually due to the presence of small isolated islands of amorphous CH material in large carbon grains (Duley and Williams, 1988).

d) The 12 and 25 μm cirrus have generally been attributed to small grains, specifically the material responsible for the UIR bands. However , except for the recent proposal of large HAC grains(see above) no mechanism has been discussed for producing the 25 μm cirrus since PAHs have no distinct strong features there. However many of the IRAS spectra appear to show a distinct rise towards long wavelengths suggesting that the 12 and 25 μm emissions are indeed related. If all the cirrus emission is indeed due to carbonaceous materials does that rule out the presence of small silicate/metal oxide clusters? And, if so, why are these clusters less stable than PAH clusters? Furthermore, the absence of stable silicate clusters argues against the recent model by Jones et al.(1987) which proposes that the more volatile carbonaceous material condenses onto the more stable silicate grains.

UV OBSERVATIONS

a) The Far-UV extinction rise has been shown by Fitzpatrick et al.(1988) to have two separate uncorrelated components: a linearly increasing term and a curvature term. This is easily explained in terms of the Mathis et al. model(see Draine and Lee, 1984) whereby they are due to separate populations of silicates and carbonaceous grains. These observations apparently contradict the Jones et al. model(1987) since it attributes all the Far-UV extinction rise to carbonaceous material which coats silicate grains. A further problem with this model is that it predicts a decreasing Far-UV extinction for the bare silicate grains which is seen neither in astronomical observations nor generally in terrestrial silicates.

b) Observations by Fitzpatrick and Massa (1986) have shown that the 2175 Å bump is nearly constant in position but varies in width. These results argue aginst the graphite explanation supported in the Mathis model. Two possible explanations that involve the presence of small grains have been proposed. Hecht(1986) has argued in favor of small de-hydrogenated amorphous CH (or HAC) grain material. The variation in the width could be due to the presence of a small amount of impurities. An argument in favor of this model is that the broadening of the bump should be correlated with the strength of the Far-UV curvature since both the bump and the curvature originate in the carbon grain component, and both features are affected by impurities. This correlation has been observed by Fitzpatrick and Massa(1988). The objections to this model are the lack of its laboratory verification, and the possible indirect implication from IR observations that carbonaceous grains are present in the SMC (Roche et al. 1987). This is significant because the SMC clearly has small grains but shows no bump. The other explanation involves the presence of small OH-bearing silicate grains or small MgO grains (Jones et al. 1987). The strengths of this model are in the laboratory studies that indicate that such grains could form a bump, and the model's natural explanation of the stability of the central wavelength of the bump peak. The deficiencies of the model involve the presence of other UV features not seen in the interstellar extinction curve, and the strength of the bump compared with other known absoption features with which the bump does not correlate i.e. IR absorption features, and the linear Far-UV rise.

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